If we consider the simple circuit of Figure 3.17, we find it has the ***v-i*** relation at its terminals of

$$v = R_{eq} i + v_{eq}$$

Comparing the two **v-i** relations, we find that they have the same form. In this case the **Thevenin equivalent resistance** is $\boldsymbol{R_{eq} = (R_1 \mid\mid R_2)}$ and the **Thevenin equivalent source** has voltage

$$v_{eq} = \frac{R_2}{R_1 + R_2} v_{in}.$$

Thus, from viewpoint of the terminals, you cannot distinguish the two circuits. Because the equivalent circuit has fewer elements, it is easier to analyze and understand than any other alternative.

For *any* circuit containing resistors and sources, the *v-i* relation will be of the form

$$v = R_{eq} i + v_{eq}$$

and the **Thevenin equivalent circuit** for any such circuit is that of Figure 3.17. This equivalence applies no matter how many sources or resistors may be present in the circuit. In the example (Example 3.2) below, we know the circuit's construction and element values, and derive the equivalent source and resistance. Because Thevenin's theorem applies in general, we should be able to make measurements or calculations **only from the terminals** to determine the equivalent circuit.

To be more specific, consider the equivalent circuit of this figure (Figure 3.17). Let the terminals be opencircuited, which has the effect of setting the current i to zero. Because no current flows through the resistor, the voltage across it is zero (remember, Ohm's Law says that $\boldsymbol{v} = \boldsymbol{Ri}$). Consequently, by applying KVL we have that the so-called open-circuit voltage v_{oc} equals the Thevenin equivalent voltage. Now consider the situation when we set the terminal voltage to zero (short-circuit it) and measure the resulting current. Referring to the equivalent circuit, the source voltage now appears entirely across the resistor, leaving the short-circuit current to be

$$i_{sc} = -\left(\frac{v_{eq}}{R_{eq}}\right)$$

. From this property, we can determine the equivalent resistance.

$$v_{eq} = v_{oc}$$

$$R_{eq} = -\left(\frac{v_{oc}}{i_{sc}}\right)$$